CLAIMS

I claim:

1. A method for reducing oscillations in an optical switch comprising:

(a) establishing a set of initial parameter values that shape an input command signal, the input command signal controlling input/output mirror actuators of the optical switch;

(b) calculating a set of new parameter values of the input command signal in accordance with an algorithm that randomly varies each initial parameter value within certain constraints;

(c) applying the input command signal to the input/output mirror actuators to produce a response by the optical switch;

(d) calculating a cost function value indicative of oscillations present in the response;

(e) comparing the cost function value to a previous cost function value, if the cost function value is less than the previous cost function value,

(i) storing the new parameter values in a memory; and

(ii) designating the new parameter values as the initial parameter values;

(f) iteratively repeating (b) – (e).

2. The method according to claim 1 wherein the new parameter values includes pre-filtering coefficients and a slope, R, of the input command signal.

3. The method of claim 2 wherein the cost function value, J(i), of an ith iteration is given as

$$J(i) = ((K - 1) \cdot V_{max} - ADC_{sum}))^2 / K$$

where K is a number of data points captured from the response, V_{max} is a final response value after settling, and ADC_{sum} is a summation of data point values.

4. The method of claim 1 wherein the response is an optical intensity feedback response of the optical switch.

5. The method of claim 2 wherein the algorithm is embodied as code for execution on a digital signal processor.

6. The method of claim 5 wherein the set of initial parameter values includes:

$$f_{n\ init} = [f_{Xi}\ f_{Yi}\ \ f_{Xo}\ f_{Yo}]$$
$$Q_{n\ init} = [Q_{nXi}\ Q_{nYi}\ \ Q_{nXo}\ Q_{nYo}]$$
$$Q_{d\ init} = [Q_{dXi}\ Q_{dYi}\ \ Q_{dXo}\ Q_{dYo}]$$
$$R_{init} = [R_{Xi}\ R_{Yi}\ \ R_{Xo}\ R_{Yo}]$$

where X_i, Y_i and X_o, Y_o represent position coordinates for the input/output mirror actuators, respectively, of the optical switch, f_n is a resonance frequency, and Q_n and Q_d are respective numerator and denominator filter response parameters.

7. The method of claim 6 wherein the algorithm comprises a set of mathematical equations that includes:

$$f_n = f_{n\ init}\,(1 + 2 \cdot f_{step} \cdot (\mathrm{rand}\,[a, b] - c))$$
$$Q_n = Q_{n\ init}\,(1 + 2 \cdot Q_{n\ step} \cdot (\mathrm{rand}\,[a, b] - c))$$
$$Q_d = Q_{d\ init}\,(1 + 2 \cdot Q_{d\ step} \cdot (\mathrm{rand}\,[a, b] - c))$$
$$R = R_{init}\,(1 + 2 \cdot R_{step} \cdot (\mathrm{rand}\,[a, b] - c))$$

where rand[a, b] is a random integer number between a and b, c is a real number, and f_{step}, $Q_{n\ step}$, $Q_{d\ step}$, and R_{step} each represent a predetermined weight value.

8. The method of claim 7 wherein a, b, and c equal 1, 4, and 0.5, respectively.

9. A method for reducing oscillations in an optical switch comprising:

(a) generating an input command signal for controlling input/output mirror actuators of the optical switch, the input command signal being generated by a digital signal processor according to an algorithm that calculates a set of new parameter values to shape the input command signal by randomly varying a set of corresponding initial parameter values within certain constraints;

(b) converting the input command signal to an analog signal;

(c) applying the analog signal to the input/output mirror actuators;

(d) capturing data points from a feedback response of the optical switch;

(e) calculating a cost function value from the data points, the cost function value indicative of oscillations present in the feedback response;

(f) comparing the cost function value to a previous cost function value, if the cost function value is less than the previous cost function value,

(i) storing the new parameter values in a memory; and

(ii) designating the new parameter values as the corresponding initial parameter values for a next iteration;

(e) iteratively repeating (a) – (f) N times, where N is an integer.

10. The method according to claim 9 wherein the new parameter values includes pre-filtering coefficients and a slope, R, of the input command signal.

11. The method of claim 10 wherein the cost function value, J(i), of an ith iteration is given as

$$J(i) = ((K - 1) \cdot V_{max} - ADC_{sum}))^2 / K$$

where K is a number of data points captured from the output response, V_{max} is a final response value after settling, and ADC_{sum} is a summation of data point values.

12. The method of claim 9 wherein the output response is an optical intensity output of the optical switch.

13. The method of claim 9 wherein the set of corresponding initial parameter values includes:

$$f_{n\ init} = [f_{Xi}\ f_{Yi}\ \ f_{Xo}\ f_{Yo}]$$
$$Q_{n\ init} = [Q_{nXi}\ Q_{nYi}\ \ Q_{nXo}\ Q_{nYo}]$$
$$Q_{d\ init} = [Q_{dXi}\ Q_{dYi}\ \ Q_{dXo}\ Q_{dYo}]$$
$$R_{init} = [R_{Xi}\ R_{Yi}\ \ R_{Xo}\ R_{Yo}]$$

where X_i, Y_i and X_o, Y_o represent position coordinates for the input/output mirror actuators, respectively, of the optical switch, f_n is a resonance frequency, and Q_n and Q_d are respective numerator and denominator filter response parameters.

14. The method of claim 13 wherein the algorithm comprises a set of mathematical equations that includes:

$$f_n = f_{n\ init}\,(1 + 2 \cdot f_{step} \cdot (\text{rand}\,[a, b] - c))$$
$$Q_n = Q_{n\ init}\,(1 + 2 \cdot Q_{n\ step} \cdot (\text{rand}\,[a, b] - c))$$
$$Q_d = Q_{d\ init}\,(1 + 2 \cdot Q_{d\ step} \cdot (\text{rand}\,[a, b] - c))$$
$$R = R_{init}\,(1 + 2 \cdot R_{step} \cdot (\text{rand}\,[a, b] - c))$$

where rand[a, b] is a random integer number between a and b, c is a real number, and f_{step}, $Q_{n\ step}$, $Q_{d\ step}$, and R_{step} each represent a predetermined weight value.

15. The method of claim 14 wherein a, b, and c equal 1, 4, and 0.5, respectively.

16. A control system for eliminating oscillations in an optical switch which includes input and output mirror-actuator assemblies, comprising:

a digital signal processor (DSP) to execute a program that generates an input command signal, the program calculating a set of new parameter values that shape the input command signal by randomly varying a set of corresponding initial parameter values within certain constraints;

a digital-to-analog converter (DAC) to convert the input command signal to an analog signal;

drivers coupled to receive the analog signal from the DAC and drive the input and output mirror-actuator assemblies in response thereto;

sensors to produce an optical intensity feedback response of the optical switch;

an analog-to-digital converter (ADC) to convert the optical intensity feedback response to a digital signal input to the DSP;

wherein the DSP is further operative to calculate a cost function value from the digital signal, the cost function value being indicative of oscillations present in the optical intensity feedback response, the DSP comparing the cost function value to a previous cost function value, if the cost function value is less than the previous cost function value the DSP storing the new parameter values in a memory and designating the new parameter values as the corresponding initial parameter values for a next iterative cycle of the program.

17. The control system of claim 16 wherein the new parameter values includes pre-filtering coefficients and a slope, R, of the input command signal.

18. The control system of claim 16 wherein the cost function value, $J(i)$, of an ith iterative cycle is given as

$$J(i) = ((K - 1) \cdot V_{max} - ADC_{sum}))^2 / K$$

where K is a number of data points captured from the optical intensity feedback response, V_{max} is a final response value after settling, and ADC_{sum} is a summation of data point values.

19. The control system of claim 16 wherein the set of corresponding initial parameter values includes:

$$f_{n\ init} = [f_{Xi}\ f_{Yi}\ \ f_{Xo}\ f_{Yo}]$$
$$Q_{n\ init} = [Q_{nXi}\ Q_{nYi}\ \ Q_{nXo}\ Q_{nYo}]$$
$$Q_{d\ init} = [Q_{dXi}\ Q_{dYi}\ \ Q_{dXo}\ Q_{dYo}]$$
$$R_{init} = [R_{Xi}\ R_{Yi}\ \ R_{Xo}\ R_{Yo}]$$

where X_i, Y_i and X_o, Y_o represent position coordinates for the input/output mirror actuators, respectively, of the optical switch, f_n is a resonance frequency, and Q_n and Q_d are respective numerator and denominator filter response parameters.

20. The control system of claim 19 wherein the program calculates a set of mathematical equations that includes:

$$f_n = f_{n\ init} (1 + 2 \cdot f_{step} \cdot (\text{rand}\ [a, b]\ - c))$$
$$Q_n = Q_{n\ init} (1 + 2 \cdot Q_{n\ step} \cdot (\text{rand}\ [a, b]\ - c))$$
$$Q_d = Q_{d\ init} (1 + 2 \cdot Q_{d\ step} \cdot (\text{rand}\ [a, b]\ - c))$$
$$R = R_{init} (1 + 2 \cdot R_{step} \cdot (\text{rand}\ [a, b]\ - c))$$

where rand[a, b] is a random integer number between a and b, c is a real number, and f_{step}, $Q_{n\ step}$, $Q_{d\ step}$, and R_{step} each represent a predetermined weight value.

21. The control system of claim 20 wherein a, b, and c equal 1, 4, and 0.5, respectively.